# A Summary of Rockfish Samples Collected from the Commercial Handline Fishery in Statistical Area 13 between July 1984 and March 1985

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# A SUMMARY OF ROCKFISH SAMPLES COLLECTED FROM THE COMMERCIAL HANDLINE FISHERY IN STATISTICAL AREA 13 BETWEEN JULY 1984 AND MARCH 1985

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## ABSTRACT

Cass, A. J., L. J. Richards, and J. R. Selsby. 1986. A summary of rockfish samples collected from the commercial handline fishery in Statistical Area 13 between July 1984 and March 1985. Can. MS Rep. Fish. Aquat Sci. 1881 : 49 p.

A biological sampling program was initiated in 1984 to establish a catch-at-age data base for the commercial rockfish fishery in the inside waters of Vancouver Island. Five commercial samples were collected from Statistical Area 13 between July 1984 and March 1985. These samples were supplemented by research samples collected within the same time period. Quillback and copper rockfish accounted for 84% and 15% of the total number of fish examined respectively. The mean length of quillback rockfish in combined commercial samples was 32.6±0.2 cm for males and 33.3±0.2 cm for females. Mean weights were 0.70±0.01 kg and 0.81±0.01 kg, respectively. There were significant differences in the size distributions of quillback rockfish between localities, seasons and with depth. Mean lengths of copper rockfish in commercial samples were 31.4±0.4 cm for males and 32.4±0.5 cm for females. Mean weights were 0.57±0.02 kg and 0.65±0.03 kg, respectively. Of the total number of quillback rockfish in samples from the commercial fishery, 84% of the males and 75% of the females were mature. The proportion of mature copper rockfish in commercial samples was similar.

## RESUME

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Un programme d'échantillonnage biologique a été amorcé en 1984 afin d'obtenir une base de données sur les prises selon l'âge pour la pêche commerciale des scorpènes dans les eaux situées entre l'île Vancouver et le continent. Cinq échantillons commerciaux ont été prélevés dans la zone statistique 13 de juillet 1984 à mars 1985. Ces échantillons ont été complétés par des échantillons de recherche prélevés au cours de la même période. Les sébastes à dos épineux et les sébastes cuivrés constituaient respectivement 84 % et 15 % du nombre total de poissons examinés. La longueur moyenne des sébastes à dos épineux de l'ensemble des échantillons commerciaux était de 32,6 ± 0,2 cm chez les mâles et de 33,3 ± 0,2 cm chez les femelles. Les poids moyens respectifs étaient de 0,70 ± 0,01 kg et de 0,81 ± 0,01 kg. Il y avait des écarts significatifs entre les distributions de tailles des sébastes à dos épineux quant à l'endroit, à la saison et à la profondeur. La longueur des moyenne sébastes cuivrés des échantillons commerciaux était de 31,4 ± 0,4 cm chez les mâles et de 32,4 ± 0,5 cm chez les femelles. Les poids moyens respectifs étaient de 0,57 ± 0,02 kg et de 0,65 ± 0.03 kg. De l'ensemble des sébastes à dos épineux des échantillons de la pêche commerciale, 84 % des mâles et 75 % des femelles étaient matures. La proportion d'individus matures des échantillons commerciaux de sébastes cuivrés était similaire.

## INTRODUCTION

The commercial handline fishery for rockfish in the Strait of Georgia and adjacent inside waters of Vancouver Island (Statistical Areas 12-20, and 28-29) has increased progressively from a mean of 42 t during 1972-77 to 302 t in 1984. This fishery is active throughout the inside waters of Vancouver Island. However, landings from Statistical Area (SA) 13 (Fig. 1) have been substantially higher over the past few years than landings from other areas. Landings from SA 13 were 196 t in 1984 or 65% of the total. More recently the fishery has expanded northward into SA 12.

The handline fishery is generally conducted from vessels ranging from 5-12 m in length. Most of the rockfish are sold live to retail and restaurant markets. In SA 13, the combined landings of several fishermen are usually stock-piled in a submerged pen until enough fish are caught to make a saleable quantity. Landings are then trucked by a fish buyer to markets located primarily in Vancouver.

Because of the growing economic importance of this fishery, we initiated a biological sampling program in 1984. The primary objective of this program is to establish a catch-at-age data base for stock assessments. In 1986, a logbook program was also introduced to collect more detailed catch information from the commercial handline fishery.

In this report we present our methods and results on size and species composition, maturity condition, size at maturity and weight-length relationships from samples collected between July 1984 and March 1985. These data are supplemented by research samples collected within the same time period during lingcod tagging studies in SA 13 (Cass, unpublished data). Research samples of rockfish were mainly used to determine the significance of depth effects on the size distribution of rockfish since depth information is absent from our commercial rockfish data.

## METHODS

### COMMERCIAL SAMPLES

Most fish landed in the commercial fishery are sold live. As it was necessary to kill fish for sampling, we were forced to purchase our samples. Because the daily catch of individual fishermen is normally less than the required sample size for biological sampling, and since we were unable to locate fishermen who individually stock-pile their own catch, it was necessary to purchase fish from the local fish buyers. A sample therefore included the catch from more than one vessel. For this reason we were unable to

differentiate between gear types used to catch the fish (i.e. bait type or size, hook size, etc). In the absence of logbook coverage during 1984-85 we were also unable to collect specific information on the locality or depth fished. However, we were able to select samples with a reasonable level of locality resolution (i.e. The Campbell River area, Stuart Island area or Kelsey Bay area).

Samples were requested from individual fish buyers usually by phone. If a sample from a particular area of interest was available we estimated the weight required based on an estimate from the fish buyer of mean fish weight and species composition. The required weight was sufficiently large to include 200 fish of the most dominant species. As the age composition of the rockfish species exploited by the handline fishery has not been determined, the appropriate sample size is not known. However, for other rockfish for which the age composition is known, sample sizes of 200 fish per sample are considered to be appropriate (Leaman, unpublished data). On some occasions we needed all the fish available. However, we were usually required to subsample from a tank containing a large volume of fish. On these occasions we took random scoops from different parts of the tank using a large dip net. We avoided dead fish that would tend to float on the surface of the tank since some species and sizes of fish may be more susceptible to handling mortality than others.

Because the fishery is active throughout the year without any apparent seasonal trend in the amount landed, we collected samples at approximately 3-mo intervals to examine seasonal variation in age, size, and sex and species composition of the catch.

All samples were sorted by species and the number of each species was recorded. Fish were either measured fresh or they were frozen and measured at a later date. All fish were examined for sex and maturity and measured for fork length to the nearest millimeter. All rockfish were weighed and otoliths were collected for ageing at a future time. The maturity conditions of quillback and copper rockfish were determined using the methods of Nagtegaal and Farlinger (1980) as modified from Westrheim (1975).

To test for the effect of freezing on the size of rockfish, we weighed and measured the length of 88 quillback rockfish before and after freezing.

## RESEARCH SAMPLES

For comparison with the commercial samples, we examined incidental catches of rockfish that were collected during lingcod tagging studies in the Strait of Georgia (Cass, unpublished data). Fishing was conducted from chartered commercial fishing vessels in each of the Campbell River and the Stuart Island areas (SA 13) (Fig 1.). Fish were caught using live herring as bait. As hook types and sizes and the size of bait herring were selected by each individual fisherman they varied among the three areas. In the Campbell

River area Mustad no. 8/0 hooks were used. In the Stuart Island area two different hook sizes were used: a forward Mustad no. 2/0 with a trailing Mustad no. 6/0 treble, and a single Mustad no. 1/0 hook. These hooks are generally larger than hooks used in the commercial handline rockfish fishery. Bait size also varied among the two areas. The herring used in the Campbell River area ranged from 15-25 cm and was larger than that used by commercial fishermen to catch rockfish. The herring used in the Stuart Island area ranged from 12-15 cm.

The total catch of copper rockfish and a subsample of quillback rockfish from the Stuart Island area were examined while fresh. The total catch of rockfish from the Campbell River area was frozen and sampled at a later date.

## RESULTS AND DISCUSSION

### SPECIES COMPOSITION

Five samples from the commercial fishery were collected from SA 13 between July 1984 and March 1985. The species composition for each sample collected is summarized in Table 1. Except for the July 1984 sample, quillback rockfish (Sebastes maliger) was dominant and accounted for 84% of the total number of fish examined. Copper rockfish (S. caurinus) was dominant in the July 1984 sample and accounted for 15% of the total number of fish examined. Differences in the proportion of quillback and copper rockfish among samples was significant (chi-square = 289, df = 4, $p<0.001$). Yelloweye rockfish (S. ruberrimus), yellowtail rockfish (S. flavidus) and kelp greenling (Hexagrammos decagrammus) were present in minor quantities and together accounted for 1% of the total number of fish examined.

The species composition of rockfish caught while tagging lingcod is summarized in Table 2. As for the commercial samples, quillback rockfish was the dominant species in our research samples. Quillback rockfish comprised 81% of the number of rockfish caught in the Campbell River area and 90% in the Stuart Island area. Copper rockfish accounted for 17% and 9%, respectively. Differences in the proportion of quillback and copper rockfish between the two areas was significant (chi-square = 13.8, df = 1, $p<0.001$). Yelloweye, tiger (S. nigrocinctus) and black rockfish (S. melanops) were in caught in minor quantities in the Campbell River area, accounting for 2% of the catch. Minor quantities of yelloweye and tiger rockfish (1%) were caught in the Stuart Island area.

## SEX COMPOSITION

The proportion of female quillback rockfish in samples collected from the commercial fishery ranged from 40-62% with a mean of 51%. Females were in highest proportion (58%) during December. The proportion of female copper rockfish in samples from the commercial fishery ranged from 39-61% with a mean of 52%.

Females accounted for 36% of the quillback rockfish in our research samples from the Campbell River Area and 48% in the Stuart Island area. The proportion of female copper rockfish was 31% and 48% in the two areas, respectively.

## SIZE COMPOSITION

The fork length of male quillback rockfish in samples from the commercial fishery ranged from 20-44 cm. Lengths of females ranged from 21-49 cm. Mean lengths (with standard error) of males and females for all samples combined were 32.6±0.2 cm and 33.3±0.2 cm, respectively. The weights of male quillback rockfish ranged from 0.1 - 1.7 kg and averaged 0.70±0.01 kg. The weights of females ranged from 0.2 - 2.2 kg and averaged 0.81±0.01 kg. Mean lengths and weights with sample variances for each commercial sample are presented in Table 3.

The size composition of quillback rockfish in our research samples was similar to samples from the commercial fishery. Lengths for males ranged from 17-45 cm with a mean of 33.0±0.03 cm and for females ranged from 23-47 cm with a mean of 34.5±0.02 cm. Weights were not recorded in research samples from the Stuart Island area. Weights of males in the Campbell River area ranged from 0.2-1.3 kg with a mean of 0.79±0.03 kg. Weights of females ranged from 0.3-1.9 kg with a mean of 0.93±0.26 kg. A summary of the size composition in our research samples is shown in Table 4.

The size composition of quillback rockfish in the samples collected from the commercial fishery is shown in Figures 2-3. We used the Kruskal-Wallis test to examine locality effects on median size and the Wilcoxon rank-sum test to examine the effect of season. To test for locality effects we compared two samples collected in December 1984 from the Stuart Island and Kelsey Bay areas. The difference in median length and weight was significant for both sexes ($p<0.001$). As shown in Figure 2 and Figure 3 the length and weight distributions of quillback rockfish from the Kelsey Bay area were highly skewed in favour of larger fish compared to all other samples. Seasonal effects were tested using samples collected from the Stuart Island area in October 1984, December 1984 and March 1985. The difference in median lengths and weights among the three samples was significant for both sexes ($p<=0.05$).

We were unable to separate the effects of locality and season on the size distribution from depth effects for commercial samples of quillback rockfish. However, research surveys in SA 15 and 16 have shown an increase in size with depth (Richards et al. 1985). It is apparent that information on depth of fishing, differences in fishing methods and size preferences of the fishermen is essential for interpreting size differences among commercial samples.

To examine the effect of depth on size distribution in research samples we compared the sizes of fish in the <20 m, 20-40 m, and >40 m depth ranges using a Kruskal-Wallis test. The size distributions of quillback rockfish caught within these depth intervals in the Campbell River and Stuart Island areas are shown in Figures 4-6. The differences in median length and weight were significant for both males ($p<0.5$) and females ($p<0.001$) in the Campbell River area. The proportion of small fish was highest in the shallow depths and declined as depth increased (Fig. 4-5). The difference in the size distribution was not significant in the Stuart Island Area ($p>0.05$). However, sample sizes in the <20 m depth range in the Stuart Island area were small ($n=11$).

To test for locality effects, we used the Wilcoxon rank-sum test to compare the length distributions for each sex of quillback rockfish from each depth range in our research samples from the Campbell River area with the corresponding distributions from the Stuart Island area. There were significant differences for females in the <20 m depth interval ($p<0.05$) and for males in the >40 m depth ($p<0.05$). There were no significant difference for either sex in the other depth intervals ($p>0.05$). Given the differences in the fishing methods used, the two areas and low sample sizes within the <20 m depth interval in the Stuart Island area, these results are inconclusive.

For copper rockfish, lengths ranged from 23-43 cm for males and 21-46 cm for females in samples collected from the commercial fishery. Mean lengths of males and females averaged 31.4±0.4 cm and 32.4±0.5 cm, respectively. Weights of copper rockfish ranged from 0.2 - 1.7 kg for males and 0.2 - 2.9 kg for females. Mean weights were 0.57±0.02 kg and 0.65±0.03 kg, respectively (Table 3). Lengths of copper rockfish in our research samples ranged from 29-47 cm for males and from 29-46 cm in length for females. Mean lengths in research samples were larger than in the commercial samples and were 35.7±0.06 cm and 37.3±0.7 cm for males and females, respectively. Weight was not measured in research samples from the Stuart Island area. In the Campbell River area, weights ranged from 0.5-2.0 kg for males with a mean of 1.03±0.11 kg. Female weight ranged from 0.5-2.9 kg with a mean of 1.28±0.11 kg (Table 4). The size distribution of copper rockfish in samples for which suitable sample sizes were collected (July 1984 and March 1985) is shown in Figures 7-8. There were significant differences in the median lengths and weights between the two samples for females ($p<0.05$) but not for males ($p>=0.05$). We were not able to test for the effects of locality, season or depth on the size distribution of copper rockfish because of small sample sizes.

## STAGES OF MATURITY

The numbers of males and females in each sample at each stage of maturity are presented in Table 5 and Table 6 for quillback and copper rockfish, respectively. A description of the stages of maturity is presented in Appendix 1.

Of the total number of quillback rockfish sampled, 84% of the males and 75% of the females were considered to be mature. The seasonal development of adult male and female quillback rockfish is shown in Figure 9. In July, 97% of all adult males and 99% of all adult females were in a resting condition. Females showed no sign of oocyte development. By October, all adult females were mature (large opaque eggs). Fertilized ova were first observed in samples collected in December. Most adult males in December were categorized as developing (65%) or developed (10%). By March, 65% of the adult females examined contained fertilized ova, 17% contained eyed eggs and 1% were spent.

Of the total number of copper rockfish sampled, 83% of the males and 74% of the females were mature. The seasonal development of copper rockfish (Table 5) was similar to that of quillback rockfish. In July, 98% of the adult female copper rockfish were in a resting stage and 2% were mature. Of the adult male copper rockfish examined in July, 68% were resting and 32% were developing. Sample sizes of copper rockfish collected during October were too small to accurately estimate the proportion at each stage for either sex. As for quillback rockfish, the first fertilized eggs in copper rockfish were observed in December (13%) although the majority of the adults were resting (50%) or mature (38%). Small sample sizes of male copper rockfish preclude an accurate estimate of the proportion of males at each stage in December. However, the majority appeared to be in a developing stage. By March 42% of the adult female copper rockfish had fertilized eggs, 17% were in a mature stage, 25% had eyed eggs, 14% were resting and 3% were spent.

## SIZE AT MATURITY

The maturity ogives for male and female quillback rockfish are shown in Figure 10 for combined commercial and research samples. The smallest mature male quillback rockfish was 21 cm. The smallest mature female was 22 cm. The largest immature male was 37 cm and the largest immature female was 45 cm. The length at 50% maturity was estimated using probit analysis. For male quillback rockfish this occurred at 27 cm (95% fiducial limits = 25-28 cm). The length at 50% maturity for females was 26 cm (95% fiducial limits = 24-28 cm).

The maturity ogives for male and female copper rockfish are shown in Fig. 11. The smallest mature male and female copper rockfish was 24 cm and 22 cm, respectively. The largest immature male was 36 cm and the largest immature female was 36 cm. The length at 50% maturity, as determined from

probit analysis, was 25 cm for males (95% fiducial limit = 21-27 cm). The length at 50% for females was 24 cm (95% fiducial limit = 16-27 cm). The wide fiducial limits for copper rockfish, particularly for females, reflect a high level of uncertainty in our estimate of the length at 50% maturity.

## FRESH VS FROZEN SAMPLES

Usually it was necessary to freeze our samples after they had been collected. A decrease in length of fish after freezing has been previously reported (Beamish et al. 1980). We weighed and measured 88 quillback rockfish from the March 1985 sample before and after freezing to test for differences due to freezing. The before and after paired observations were compared using the Wilcoxon signed-ranks test. The difference was significant for both weight ($p<0.001$) and for fork length ($p<0.05$). However, the differences were small. The mean weight of fish after freezing and thawing was 3±1.4 g heavier than before freezing. The mean length after freezing decreased by only 1±0.5 mm. While the difference is statistically significant, the actual difference is inconsequential at the level of precision required for our studies.

## WEIGHT-LENGTH RELATIONSHIPS

The relationship between length and weight for male and female quillback and copper rockfish in samples from the commercial fishery is shown in Figures 12 and 13. Parameter estimates and corresponding $r^2$ values for the weight-length regression $W = aL^b$, where W is weight and L is fork length, for each sample of quillback and copper rockfish are presented in Tables 7 and 8, respectively.

## ACKNOWLEDGMENTS

We are indebted to the fishermen and fish buyers who provided samples for this project.

## REFERENCES

Beamish, R. J., C. Houle, and R. Scarsbrook. 1980. A summary of sablefish tagging and biological studies conducted during 1979 by the Pacific Biological Station. Can. MS Rep. Fish. Aquat. Sci. 1588: 194 p.

Naytegaal, D. A. and S. P. Farlinger. 1980. Catches and trawl locations of M/V BLUE WATERS during rockfish exploration and assessment cruise to the west coast of the Queen Charlotte Islands, 1979. Can. Data Rep. Fish. Aquat. Sci. 215: 74 p.

Richards, L. J., A. J. Cass, J. R. Selsby, R. van den Broek, and S. D. Loynachan. 1985. A summary of research catch and effort data for nearshore reef-fishes collected during 1984 in MSA 15 and 16 of the Strait of Georgia. Can. MS Rep. Fish. Aquat. Sci. 1833: 69 p.

Westrheim, S. J. 1975. Reproduction, maturation, and identification of larvae of some Sebastes (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32: 2399-2411.

Table 1. Species composition of rockfish in samples from the commercial rockfish handline fishery in Statistical Area 13 between July 1984 and March 1985.

| Date of purchase | Locality | Species | Species no. | Composition % |
|---|---|---|---|---|
| July/84 | Campbell River | Quillback | 96 | 47.3 |
| | | Copper | 107 | 52.7 |
| October/84 | Stuart Island | Quillback | 150 | 81.5 |
| | | Copper | 25 | 13.6 |
| | | Kelp Greenling | 9 | 4.9 |
| December/84 | Kelsey Bay | Quillback | 225 | 99.1 |
| | | Copper | 2 | 0.9 |
| December/84 | Stuart Island | Quillback | 319 | 93.8 |
| | | Copper | 21 | 6.2 |
| March/85 | Stuart Island | Quillback | 595 | 86.5 |
| | | Copper | 85 | 12.4 |
| | | Yelloweye | 2 | 0.3 |
| | | Yellowtail | 1 | 0.1 |
| | | Kelp Greenling | 5 | 0.7 |

Table 2. Species composition of rockfish in samples collected during lingcod tagging studies in Statistical Area 13 between November 1984 and March 1985.

| Date | Locality | Species | Species No. | Composition % |
|---|---|---|---|---|
| November-March | Campbell River | Quillback | 250 | 81.4 |
| | | Copper | 51 | 16.7 |
| | | Tiger | 4 | 1.3 |
| | | Yelloweye | 1 | 0.3 |
| | | Black | 1 | 0.3 |
| January-February | Stuart Island | Quillback | 630 | 90.1 |
| | | Copper | 61 | 8.7 |
| | | Tiger | 4 | 0.6 |
| | | Yelloweye | 4 | 0.6 |

Table 3. Mean lengths (cm) and weights (kg) with one standard error for rockfish in commercial handline samples collected from Statistical Area 13 between July 1984 and March 1985.

| Date of Purchase | Locality | No. of fish | Mean length Male | (SE) | Female | (SE) | Mean weight Male | (SE) | Female | (SE) |
|---|---|---|---|---|---|---|---|---|---|---|
| A. Quillback Rockfish | | | | | | | | | | |
| July/84 | Campbell River | 96 | 30.2 | (0.69) | 31.8 | (0.63) | 0.60 | (0.039) | 0.69 | (0.045) |
| October/84 | Stuart Island | 150 | 32.5 | (0.49) | 31.6 | (0.58) | 0.67 | (0.034) | 0.65 | (0.037) |
| December/84 | Kelsey Bay | 225 | 39.2 | (0.25) | 39.1 | (0.37) | 1.24 | (0.044) | 1.26 | (0.026) |
| December/84 | Stuart Island | 319 | 33.4 | (0.31) | 33.7 | (0.33) | 0.78 | (0.021) | 0.84 | (0.025) |
| March/85 | Stuart Island | 595 | 31.1 | (0.22) | 30.6 | (0.28) | 0.56 | (0.011) | 0.59 | (0.017) |
| B. Copper Rockfish | | | | | | | | | | |
| July/84 | Campbell River | 107 | 31.3 | (0.63) | 33.6 | (0.78) | 0.60 | (0.035) | 0.72 | (0.052) |
| October/84 | Stuart Island | 25 | 28.3 | (0.60) | 29.4 | (1.07) | 0.40 | (0.029) | 0.46 | (0.048) |
| December/84 | Kelsey Bay | 2 | 38.0 | - | 40.0 | - | 1.00 | - | 1.20 | - |
| December/84 | Stuart Island | 21 | 35.3 | (1.93) | 35.5 | (1.30) | 0.89 | (0.138) | 0.87 | (0.092) |
| March/85 | Stuart | 85 | 31.3 | (0.49) | 31.2 | (0.597) | 0.50 | (0.023) | 0.56 | (0.034) |

Table 4. Mean lengths (cm) and weights (kg) with one standard error for rockfish in research handline samples collected during lingcod tagging studies in Statistical Area 13 between November 1984 and March 1985.

| Date | Locality | No. of fish | Mean length | | | | Mean weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | (SE) | Female | (SE) | Male | (SE) | Female | (SE) |
| A. Quillback Rockfish | | | | | | | | | | |
| November-March | Campbell River | 250 | 33.4 | (0.49) | 34.6 | (0.33) | 0.79 | (0.030) | 0.93 | (0.026) |
| January-February | Stuart Island | 298 | 32.6 | (0.35) | 34.4 | (0.29) | - | - | - | - |
| B. Copper Rockfish | | | | | | | | | | |
| November-March | Campbell River | 51 | 37.6 | (1.20) | 39.1 | (1.14) | 1.04 | (0.106) | 1.29 | (0.110) |
| January-February | Stuart Island | 61 | 34.8 | (0.48) | 35.6 | (0.51) | - | - | - | - |

Table 5. Maturity stages observed in samples of quillback rockfish from Statistical Area 13 between July 1984 and March 1985.

| Maturity Stage | Campbell River July/84 | | Stuart Island October/84 | | Stuart Island December/84 | | Kelsey Bay December/84 | | Stuart Island March/85 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | no. | (%) | No. | (%) | No. | (%) |
| A. Males | | | | | | | | | | |
| Immature | 4 | (8.2) | 8 | (11.0) | 9 | (6.2) | 0 | (0.0) | 62 | (17.4) |
| Maturing | 8 | (16.3) | 7 | (10.0) | 5 | (3.4) | 0 | (0.0) | 14 | (3.9) |
| Developing | 1 | (2.0) | 58 | (79.5) | 88 | (60.3) | 53 | (36.3) | 0 | (0.0) |
| Developed | 0 | (0.0) | 0 | (0.0) | 1 | (0.7) | 20 | (13.7) | 0 | (0.0) |
| Running | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) |
| Spent | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) |
| Resting | 36 | (73.5) | 0 | (0.0) | 43 | (29.5) | 13 | (8.9) | 281 | (78.7) |

| Maturity Stage | Campbell River July/84 | | Stuart Island October/84 | | Stuart Island December/84 | | Kelsey Bay December/84 | | Stuart Island March/85 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | no. | (%) | No. | (%) | No. | (%) |
| B. Females | | | | | | | | | | |
| Immature | 0 | (0.0) | 1 | (1.3) | 15 | (8.7) | 0 | (0.0) | 36 | (15.2) |
| Maturing | 5 | (10.6) | 22 | (28.6) | 55 | (31.8) | 20 | (14.4) | 11 | (4.6) |
| Mature | 1 | (2.1) | 54 | (70.1) | 80 | (46.2) | 67 | (48.2) | 16 | (6.8) |
| Fertilized | 0 | (0.0) | 0 | (0.0) | 11 | (6.4) | 26 | (18.7) | 124 | (52.3) |
| Eyed eggs | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 33 | (13.9) |
| Spent | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 8 | (5.8) | 2 | (0.8) |
| Resting | 41 | (87.2) | 0 | (0.0) | 11 | (6.4) | 18 | (12.9) | 15 | (6.3) |
| Resorbing | 0 | (0.0) | 0 | (0.0) | 1 | (0.6) | 0 | (0.0) | 0 | (0.0) |

Table 6. Maturity stages observed in samples of copper rockfish from Statistical Area 13 between July 1984 and March 1985.

| Maturity Stage | Campbell River July/84 | | Stuart Island October/84 | | Stuart Island December/84 | | Kelsey Bay December/84 | | Stuart Island March/85 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| A. Males | | | | | | | | | | |
| Immature | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 3 | (7.0) |
| Maturing | 14 | (24.1) | 0 | (0.0) | 0 | (0.0) | 1 | (12.5) | 2 | (4.7) |
| Developing | 14 | (24.1) | 9 | (100.0) | 0 | (0.0) | 5 | (62.5) | 0 | (0.0) |
| Developed | 0 | (0.0) | | - | | - | 0 | (0.0) | 0 | (0.0) |
| Running | 0 | (0.0) | | - | | - | 0 | (0.0) | 0 | (0.0) |
| Spent | 0 | (0.0) | | - | | - | 0 | (0.0) | 0 | (0.0) |
| Resting | 30 | (51.7) | | - | | - | 2 | (25.0) | 38 | (88.4) |

| Maturity Stage | Campbell River July/84 | | Stuart Island October/84 | | Stuart Island December/84 | | Kelsey Bay December/84 | | Stuart Island March/85 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) | No. | (%) | No. | (%) |
| B. Females | | | | | | | | | | |
| Immature | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 1 | (7.7) | 6 | (14.3) |
| Maturing | 6 | (12.2) | 14 | (100.0) | 0 | (0.0) | 4 | (30.8) | 0 | (0.0) |
| Mature | 1 | (2.0) | 0 | (0.0) | 1 | (100.0) | 3 | (23.1) | 6 | (14.3) |
| Eyed eggs | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 9 | (21.4) |
| Spent | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 1 | (2.4) |
| Resting | 42 | (85.7) | 0 | (0.0) | 0 | (0.0) | 4 | (30.8) | 5 | (11.9) |
| Resorbing | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | ( 0.0) | 0 | (0.0) |

Table 7. Parameter estimates for the log-transformed weight-length regression; $W = aL^b$, where W is weight (g) and L is length (mm), for samples of quillback rockfish sampled from the commercial handline fishery in the inside waters of Vancouver Island between July 1984 through March 1985.

| Area | Date | a | b | $r^2$ | N |
|---|---|---|---|---|---|
| A. Males | | | | | |
| Campbell River | July 1984 | -2.854 | 2.707 | 0.89 | 49 |
| Stuart Island | October 1984 | -3.970 | 3.019 | 0.93 | 70 |
| Kelsey Bay | December 1984 | -2.494 | 2.619 | 0.76 | 86 |
| Stuart Island | December 1984 | -3.959 | 3.025 | 0.95 | 146 |
| Stuart Island | March 1985 | -3.445 | 2.849 | 0.94 | 356 |
| B. Females | | | | | |
| Campbell River | July 1984 | -4.486 | 3.184 | 0.94 | 46 |
| Stuart Island | October 1984 | -3.951 | 3.013 | 0.96 | 75 |
| Kelsey Bay | December 1984 | -2.863 | 2.727 | 0.83 | 138 |
| Stuart Island | December 1984 | -4.085 | 3.054 | 0.91 | 237 |
| Stuart Island | March 1985 | -3.854 | 3.002 | 0.90 | 173 |

Table 8. Parameter estimates for the log-transformed weight-length regression; $W = aL^b$, where W is weight (g) and L is length (mm), for samples of copper rockfish sampled from the commercial handline fishery in the inside waters of Vancouver Island between July 1984 and March 1985.

| Area | Date | a | b | $r^2$ | N |
|---|---|---|---|---|---|
| A. Males | | | | | |
| Campbell River | July 1984 | -3.614 | 2.902 | 0.94 | 56 |
| Stuart Island | March 1985 | -3.387 | 2.798 | 0.95 | 43 |
| **Area** | **Date** | **a** | **b** | **R** | **N** |
| B. Females | | | | | |
| Campbell River | July 1984 | -3.408 | 2.845 | 0.95 | 45 |
| Stuart Island | March 1985 | -3.803 | 2.944 | 0.95 | 42 |

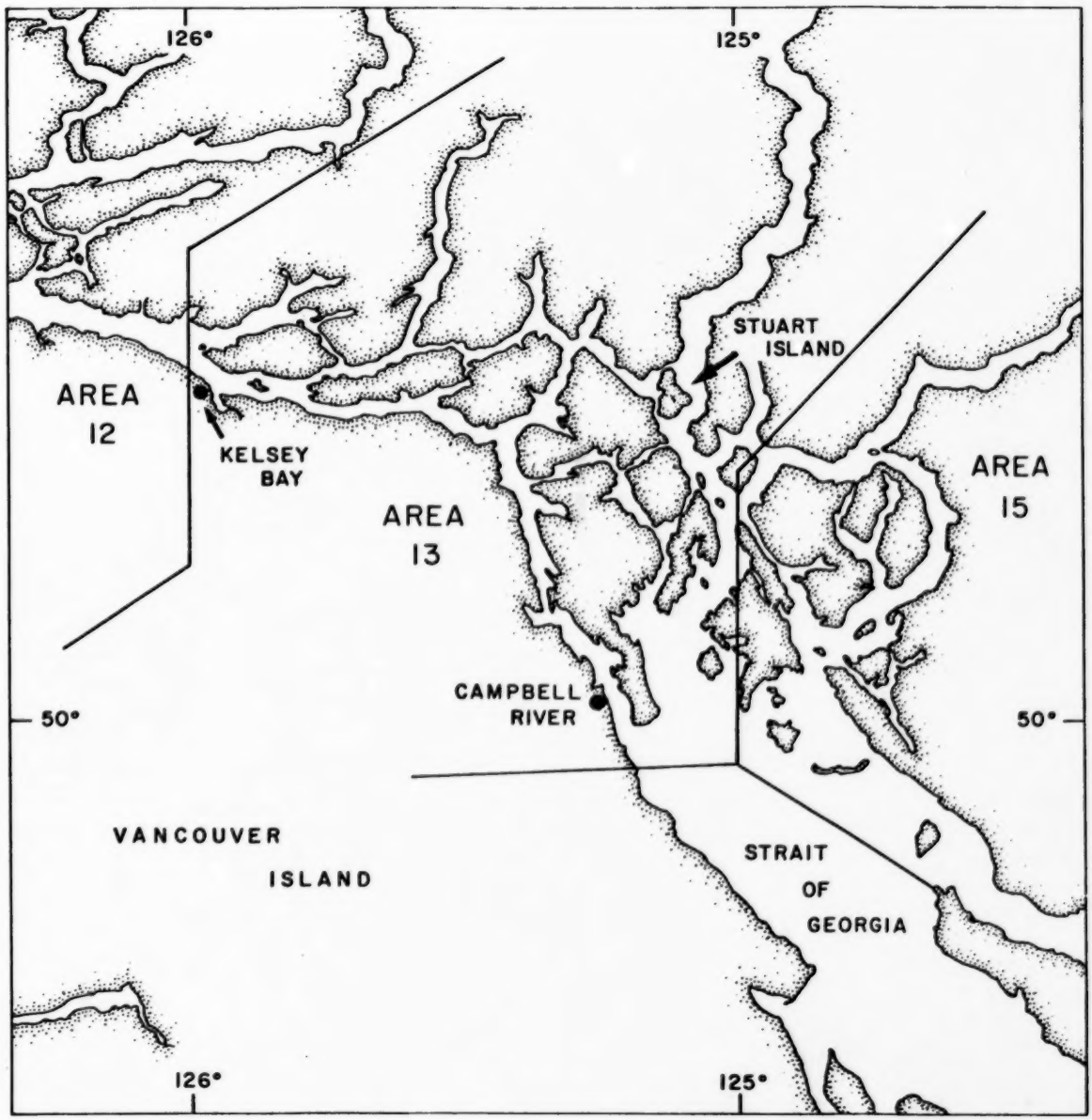



Fig. 1. Fishing areas from which samples of nearshore rockfish were collected between July 1984 and March 1985.

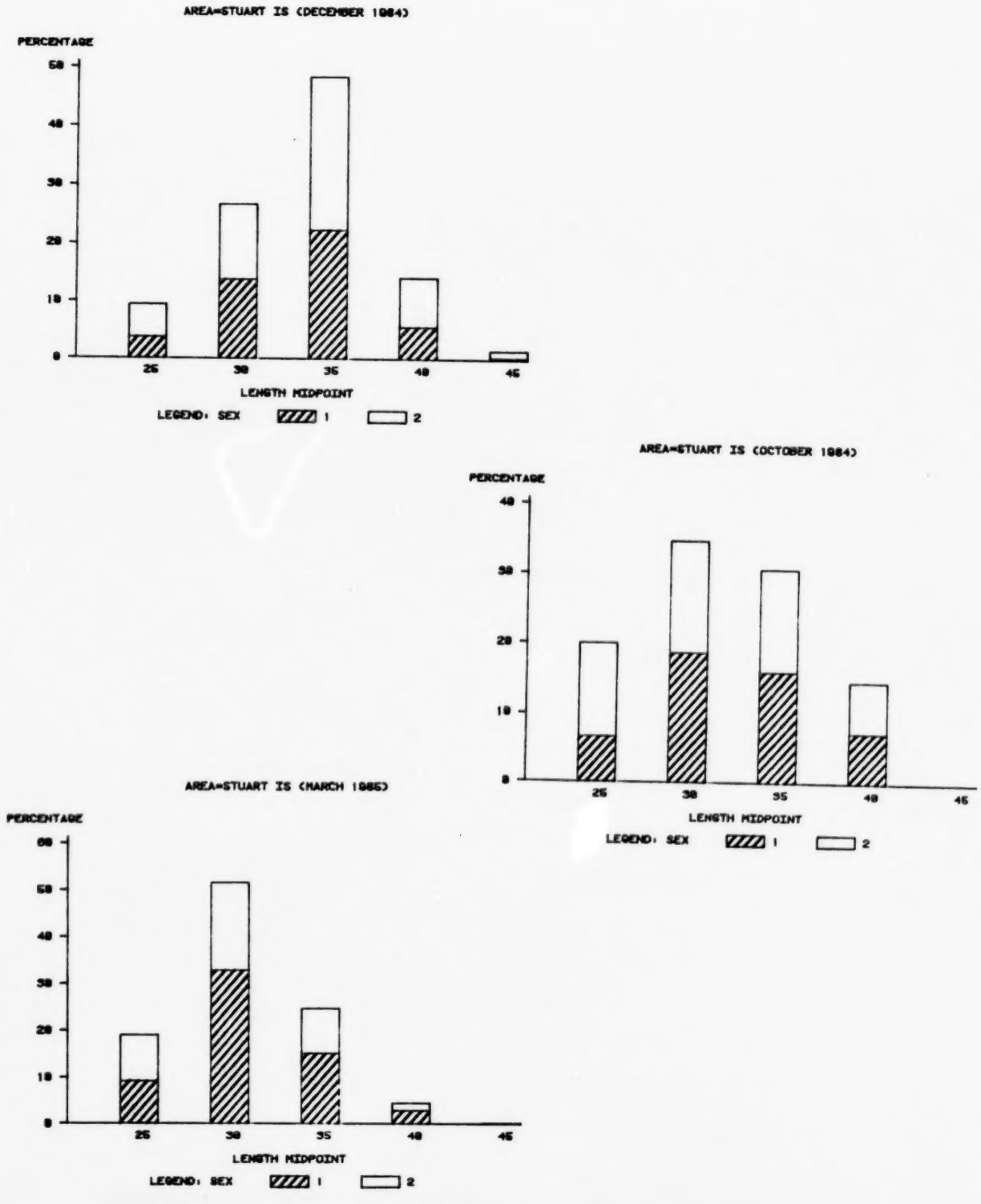
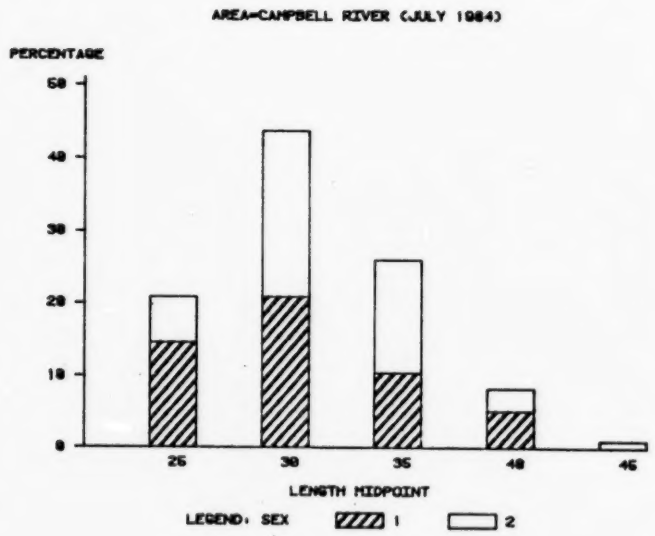



Fig. 2. Length distributions by sex for quillback rockfish in samples collected between July 1984 and March 1985 from the commercial rockfish handline fishery by area and date of collection. Lengths shown are the midpoints of 5-cm size classes. Male = 1 Females = 2.


AREA=CAMPBELL RIVER (JULY 1984)
PERCENTAGE
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40
30
20
10
0
25
30
35
40
45
LENGTH MIDPOINT
LEGEND: SEX
1
2

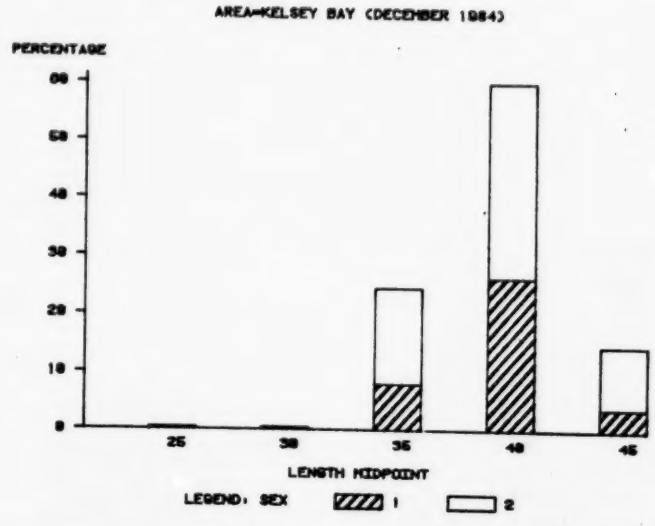

AREA=KELSEY BAY (DECEMBER 1984)
PERCENTAGE
60
50
40
30
20
10
0
25
30
35
40
45
LENGTH MIDPOINT
LEGEND: SEX
1
2

Fig. 2 (cont'd)

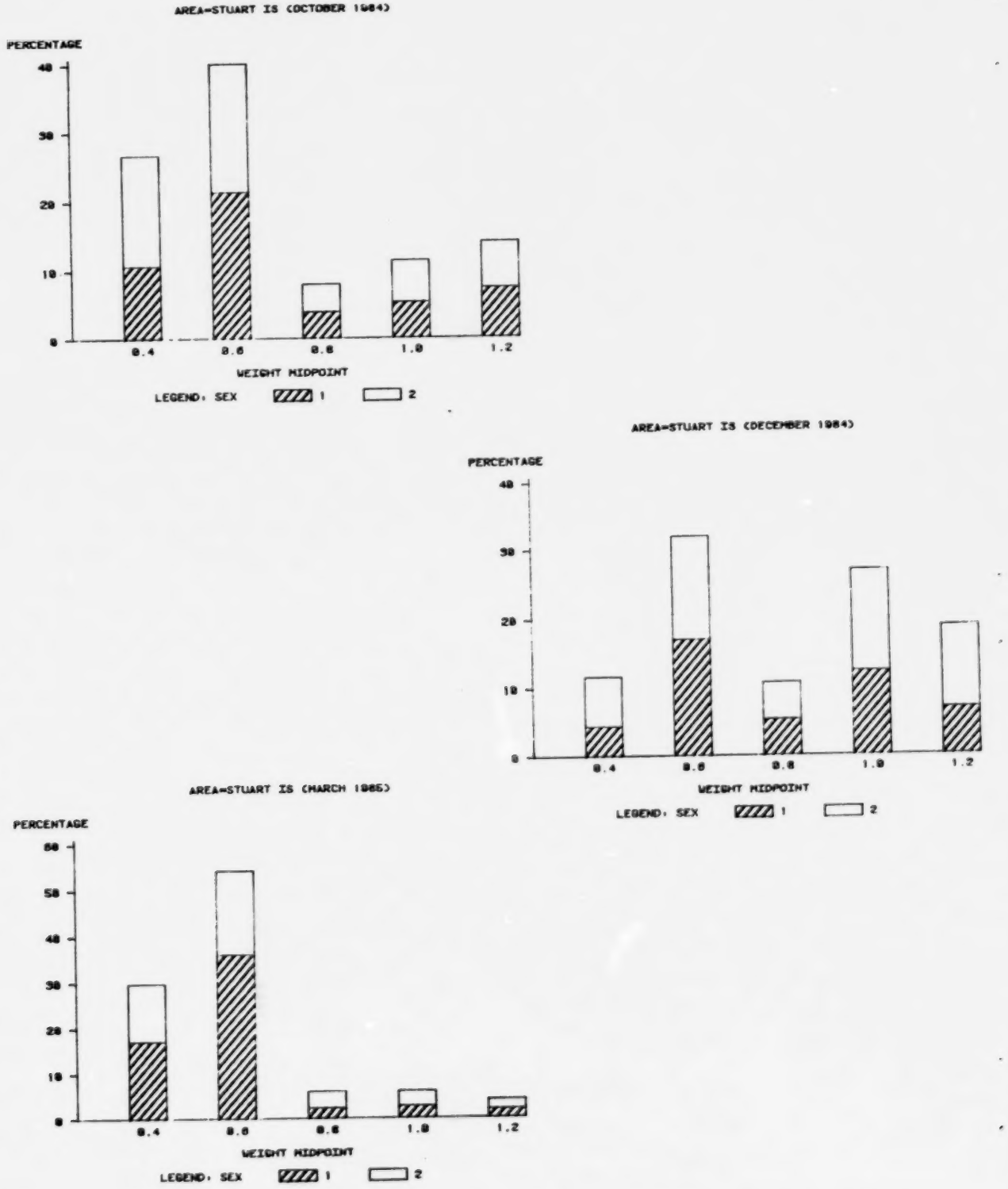
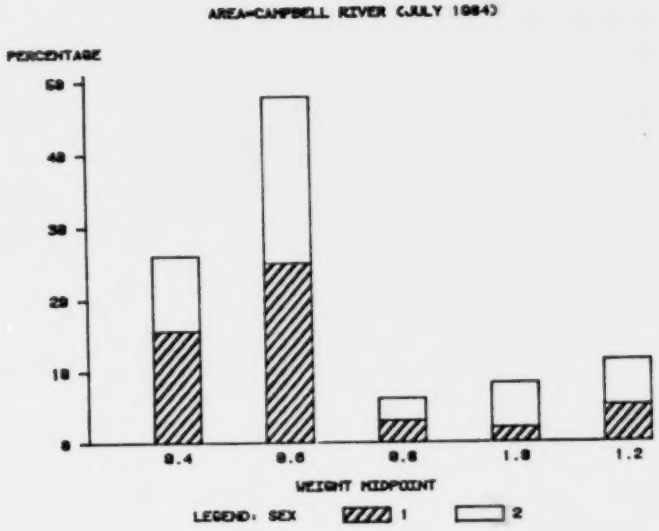



Fig. 3. Weight distributions by sex for quillback rockfish in samples collected between July 1984 and March 1985 from the commercial rockfish handline fishery by area and date of collection. Weights shown are the midpoints of 0.2-kg size classes. Male = 1 Females = 2.


AREA=CAMPBELL RIVER (JULY 1984)
PERCENTAGE
50
40
30
20
10
0
0.4
0.6
0.8
1.0
1.2
WEIGHT MIDPOINT
LEGEND: SEX
1
2

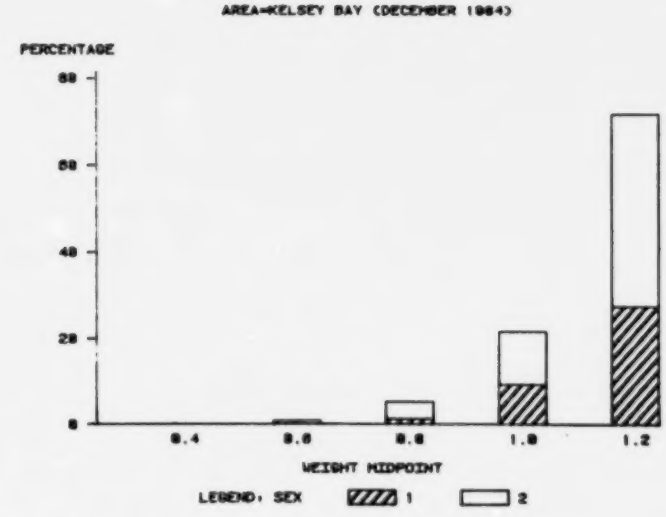

AREA=KELSEY BAY (DECEMBER 1984)
PERCENTAGE
80
60
40
20
0
0.4
0.6
0.8
1.0
1.2
WEIGHT MIDPOINT
LEGEND: SEX
1
2

Fig. 3 (cont'd)

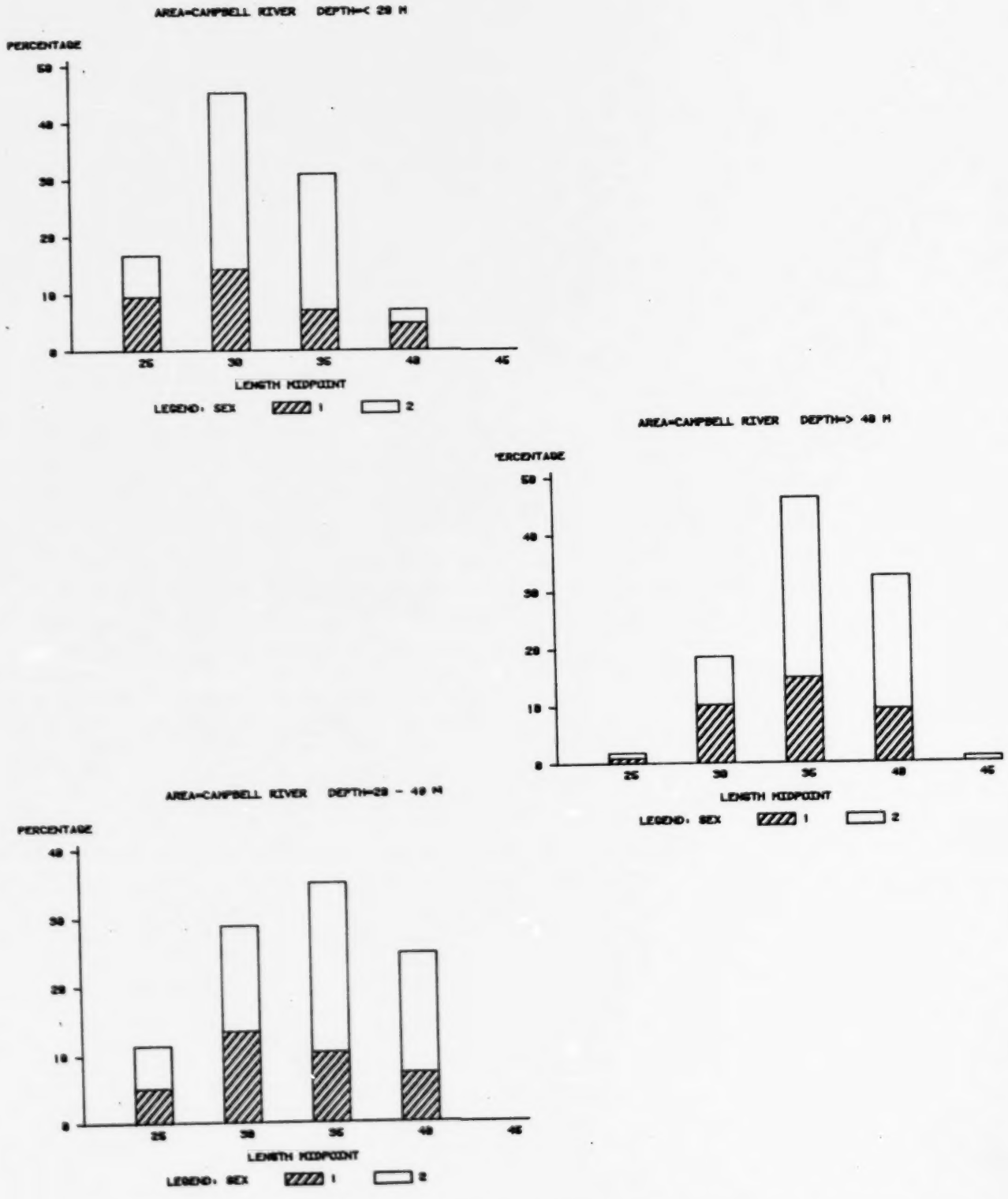



Fig. 4. Length distributions by sex for quillback rockfish in samples collected during lingcod tagging studies in the Campbell River area between November 1984 and March 1985 by depth range. Lengths shown are the midpoints of 5-cm size classes. Male = 1 Females = 2.

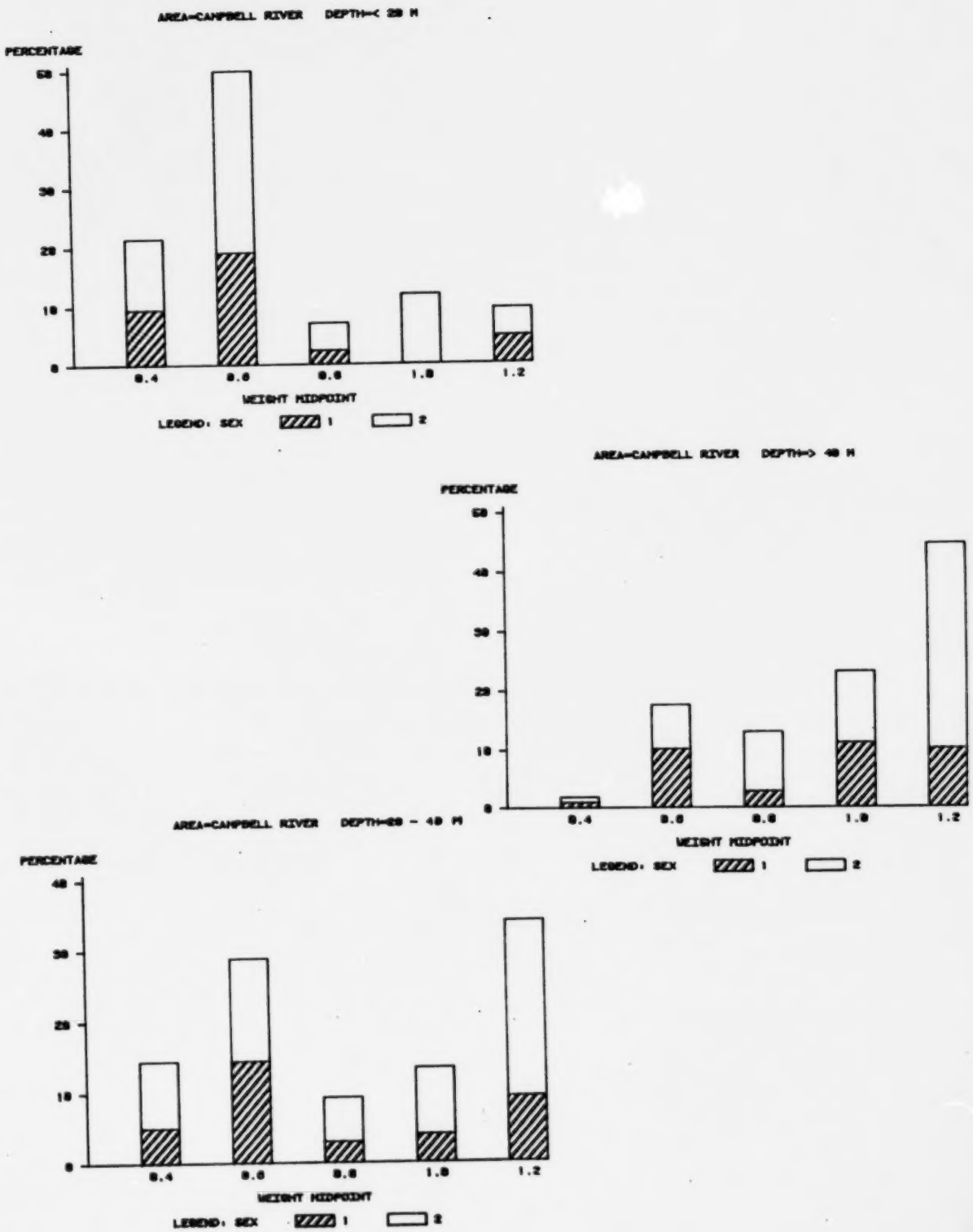



Fig. 5. Weight distributions by sex for quillback rockfish in samples collected during lingcod tagging studies in the Campbell River area between November 1984 and March 1985 by depth range. Weights shown are the midpoints of 0.2-kg size classes. Male = 1 Female = 2.

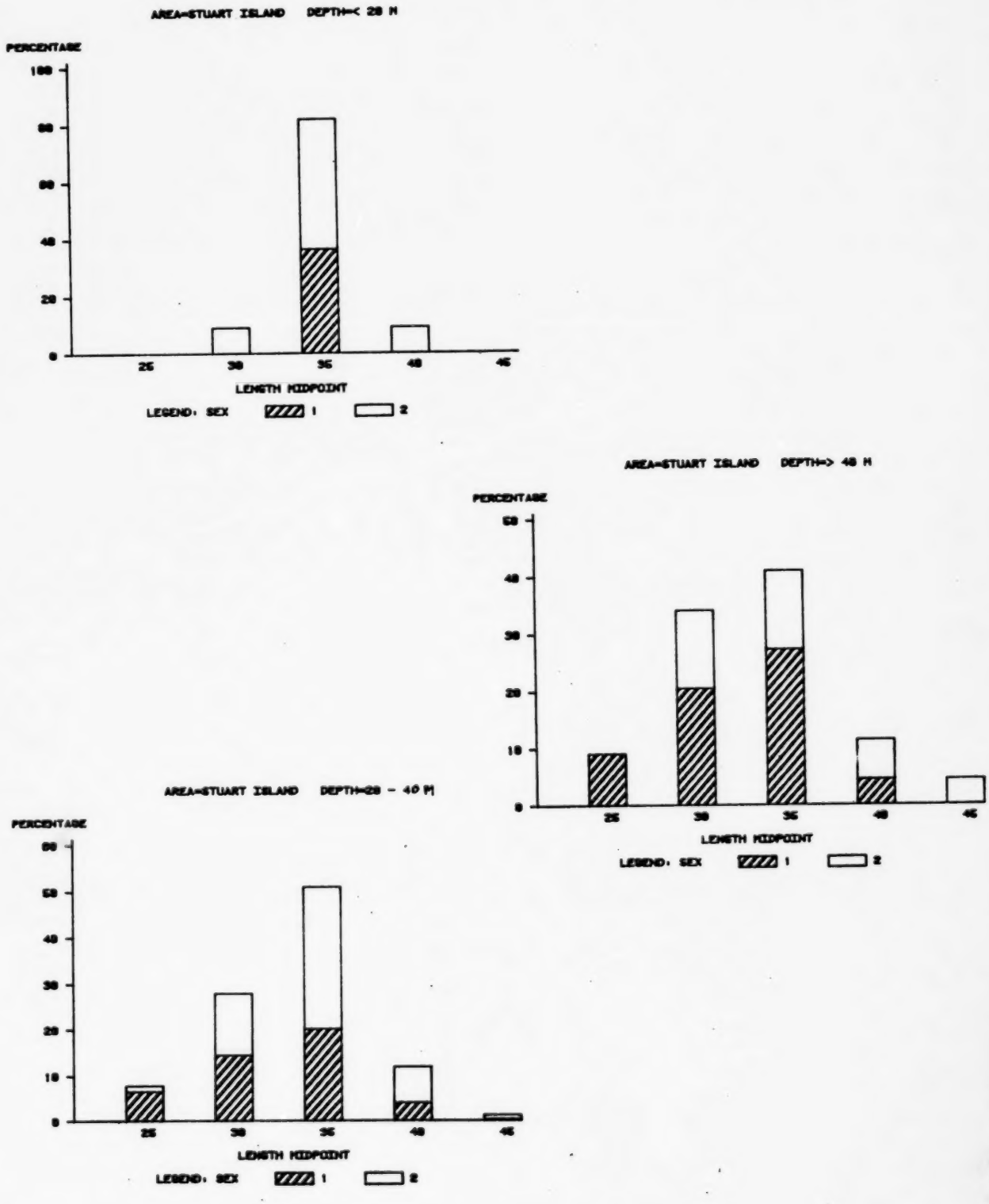
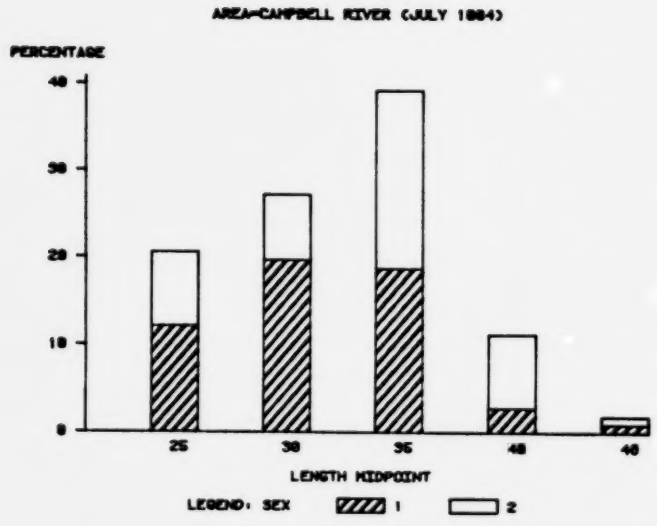



Fig. 6. Length distributions by sex for quillback rockfish in samples collected during lingcod tagging studies in the Stuart Island area between January and February 1985 by depth range. Lengths shown are the midpoints of 5-cm size classes. Male = 1 Female = 2.



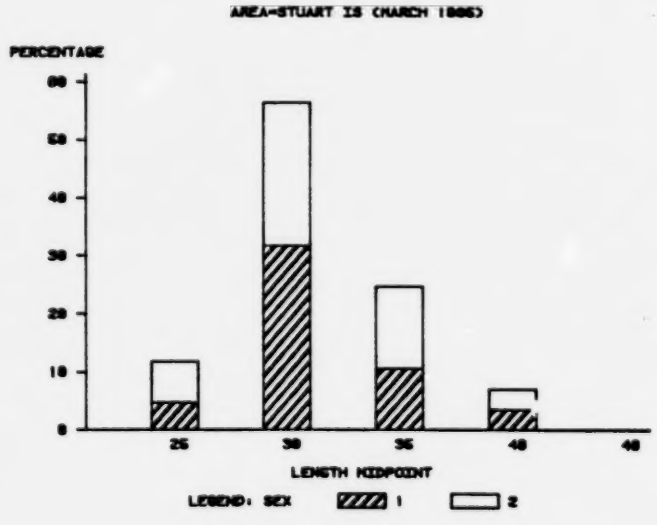
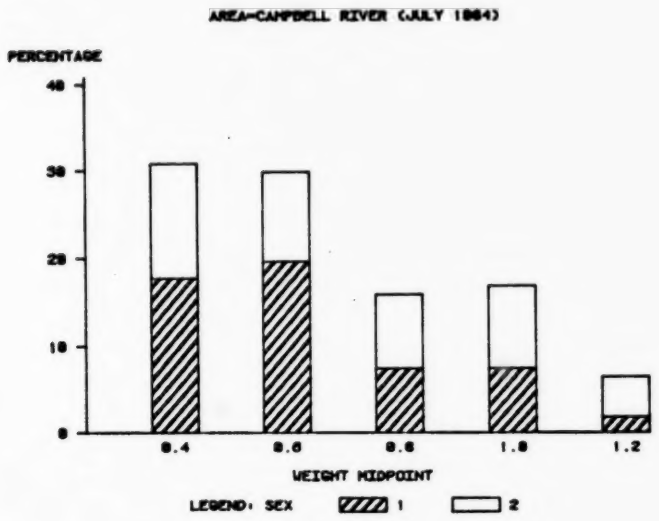




Fig. 7. Length distributions by sex for copper rockfish in samples collected between July 1984 and March 1985 from the commercial rockfish handline fishery by area and date of collection. Lengths shown are the midpoints of 5-cm size classes. Male = 1 Female = 2.



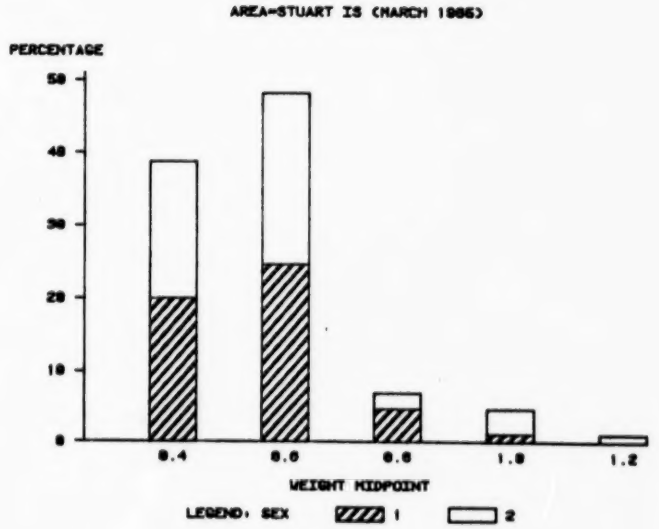




Fig. 8. Weight distributions by sex for copper rockfish in samples collected between July 1984 and March 1985 from the commercial rockfish handline fishery by area and date of collection. Weights shown are the midpoints of 0.2-kg size classes. Male = 1 Female = 2.

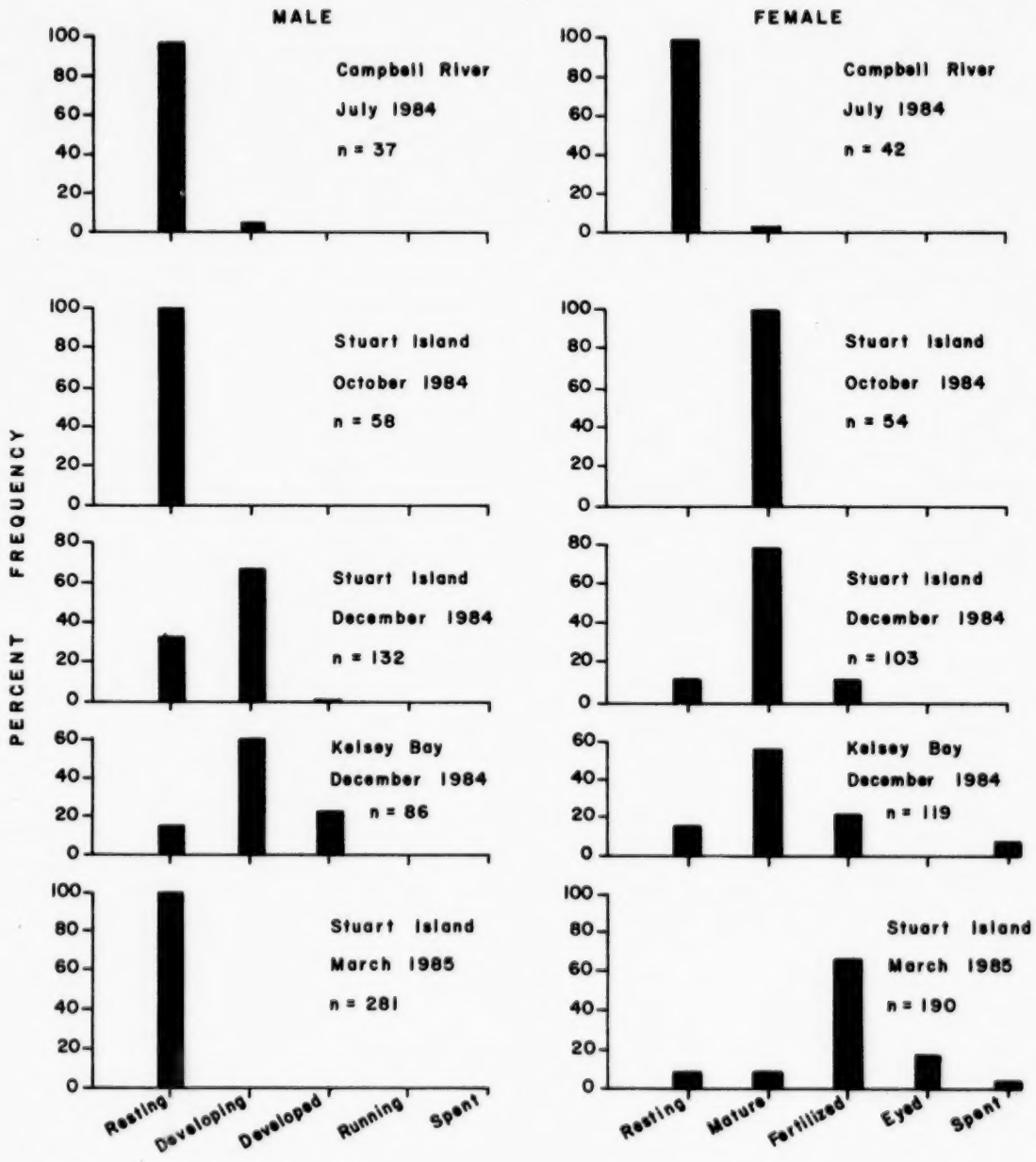



Fig. 9. The proportion of adult male and female quillback rockfish at each stage of maturity in commercial samples collected from the commercial rockfish handline fishery between July 1984 and March 1985.

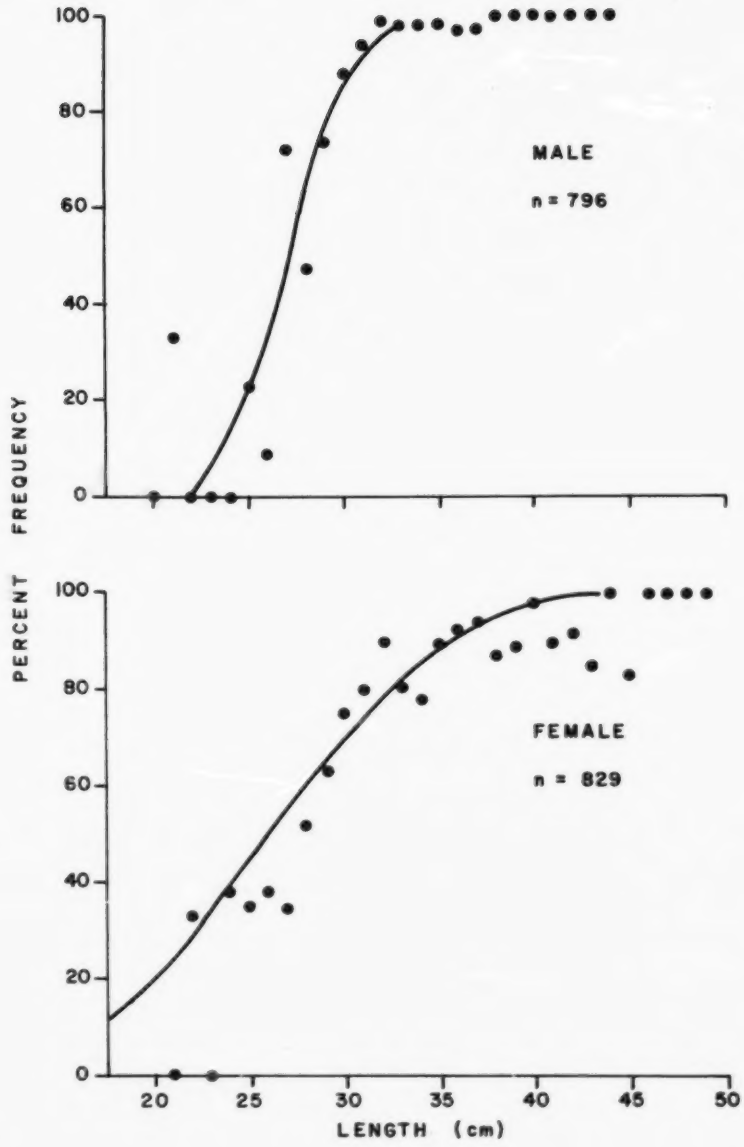



Fig. 10. Maturity ogives for male and female quillback rockfish in combined commercial and research samples collected between July 1984 and March 1985 from Statistical Area 13. The line shows the probability of mature fish at length as estimated from probit analysis.

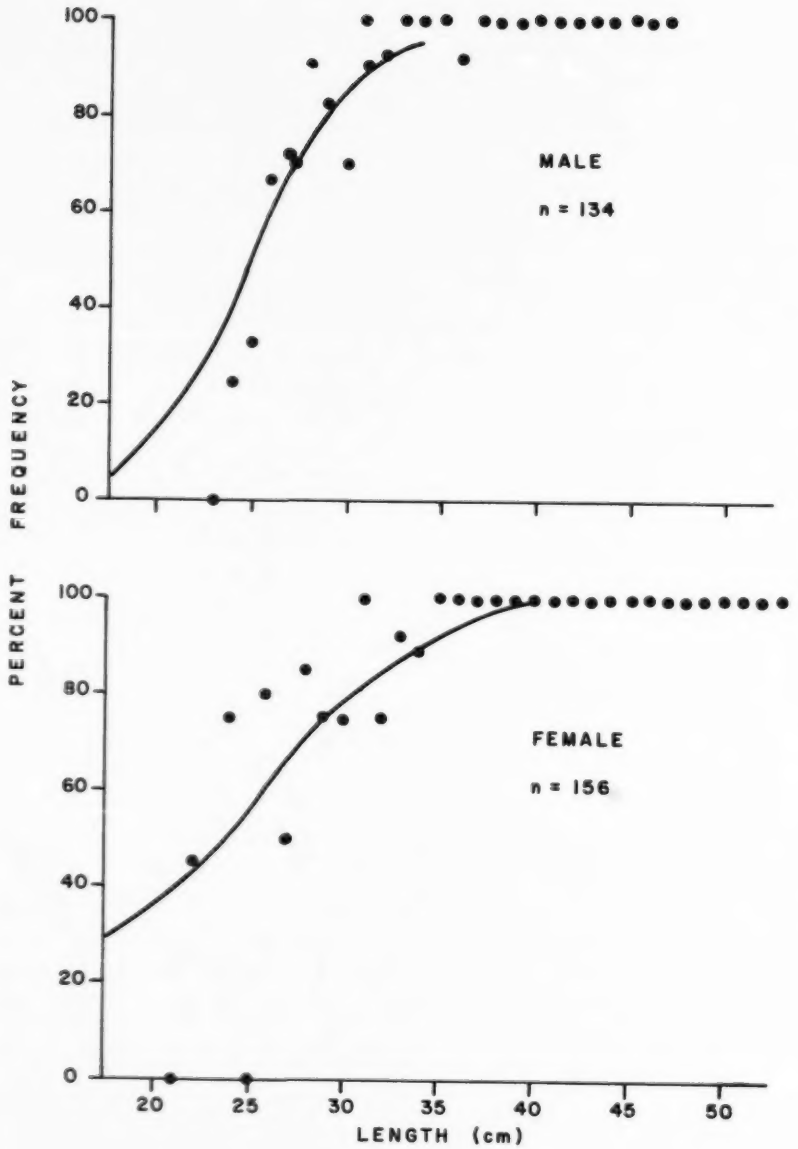
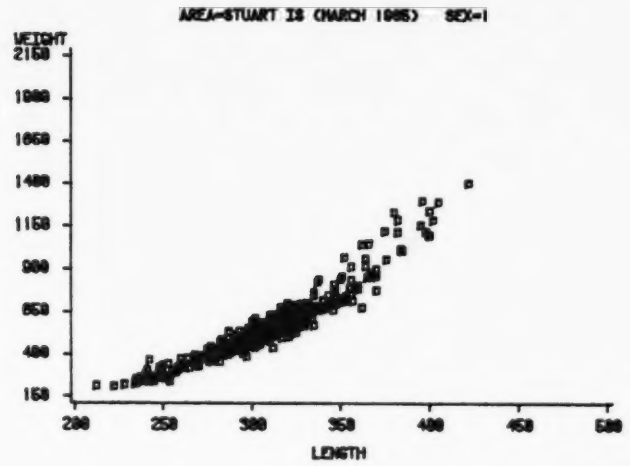



Fig. 11. Maturity ogives for male and female copper rockfish in combined commercial and research samples collected between July 1984 and March 1985 from Statistical Area 13. The line shows the probability of mature fish at length as estimated from probit analysis.



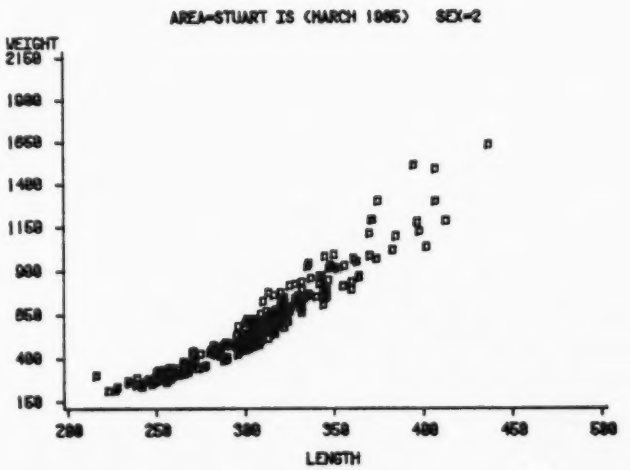
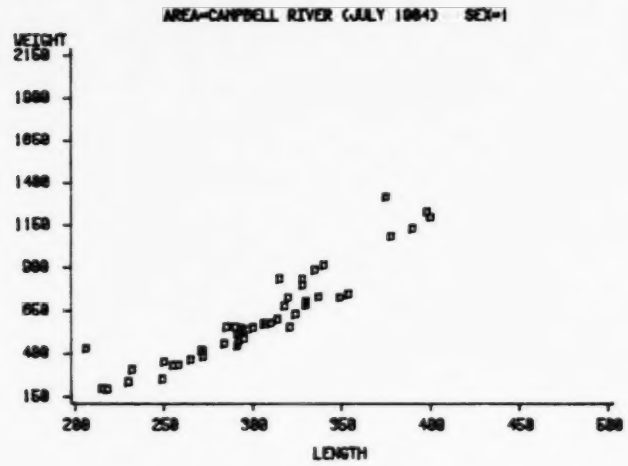




Fig 12. Weight-length relationships for each sex of quillback rockfish in samples collected from the commercial nearshore handline fishery in Statistical Areas 12 and 13 during July 1984 through March 1985 by area and date of collection. Male = 1 Female = 2.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WEIGHT
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1900
1650
1400
1150
900
650
400
150
200
250
300
350
400
450
500
LENGTH

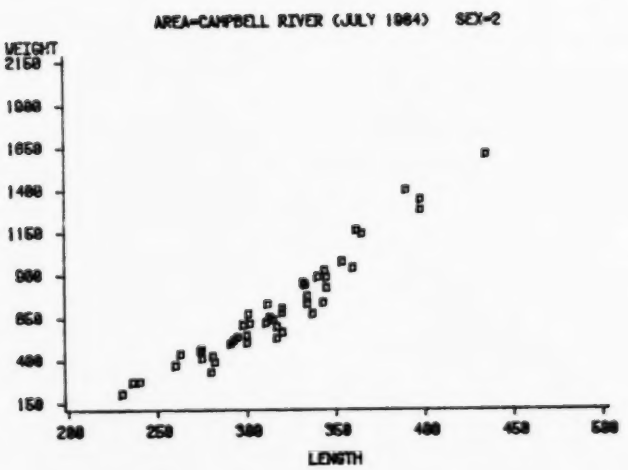
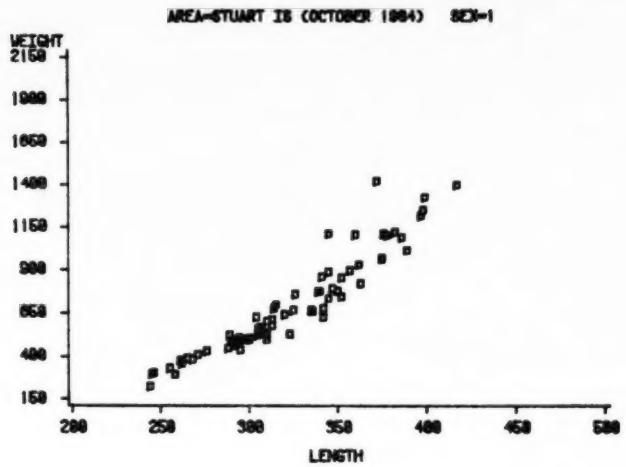

AREA=CAMPBELL RIVER (JULY 1984) SEX=2
WEIGHT
2150
1900
1650
1400
1150
900
650
400
150
200
250
300
350
400
450
500
LENGTH

Fig. 12 (cont'd)


AREA=STUART IS (OCTOBER 1984) SEX=1
WEIGHT
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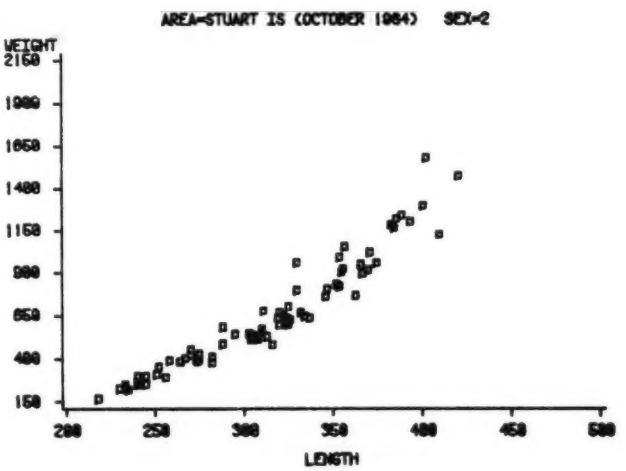
1650
1400
1150
900
650
400
150
200
250
300
350
400
450
500
LENGTH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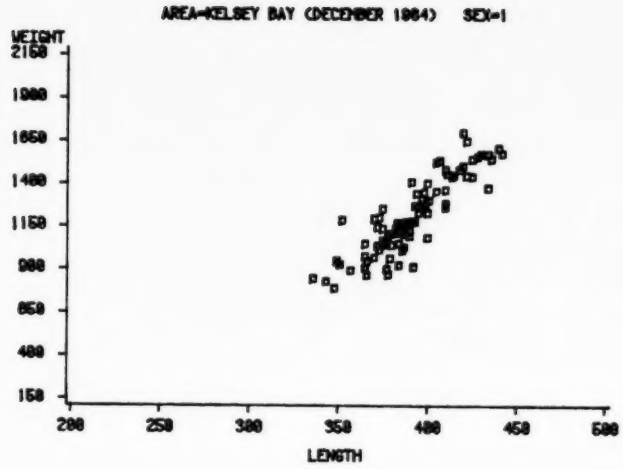
1900
1650
1400
1150
900
650
400
150
200
250
300
350
400
450
500
LENGTH

Fig. 12 (cont'd)


AREA=KELSEY BAY (DECEMBER 1984) SEX=1
WEIGHT
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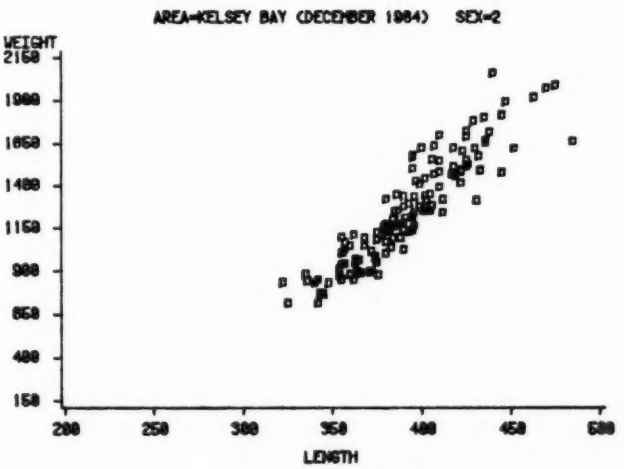
1650
1400
1150
900
650
400
150
200
250
300
350
400
450
500
LENGTH


AREA=KELSEY BAY (DECEMBER 1984) SEX=2
WEIGHT
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1900
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1400
1150
900
650
400
150
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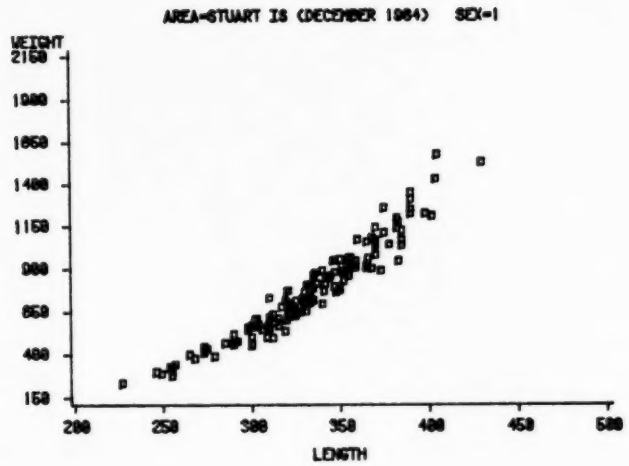
250
300
350
400
450
500
LENGTH

Fig. 12 (cont'd)


AREA-STUART IS (DECEMBER 1984) SEX=1
WEIGHT
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1900
1650
1400
1150
900
650
400
150
200
250
300
350
400
450
500
LENGTH

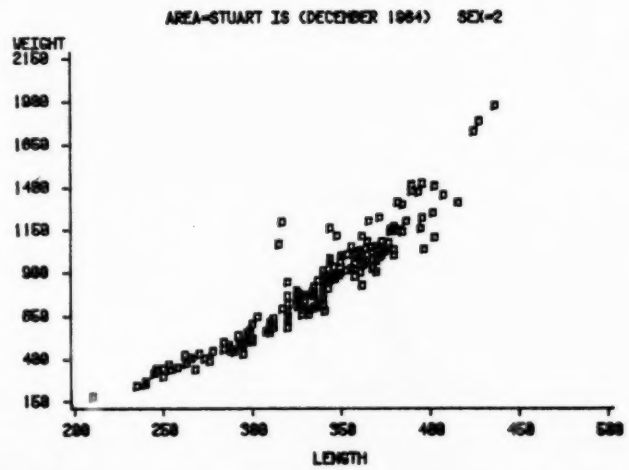
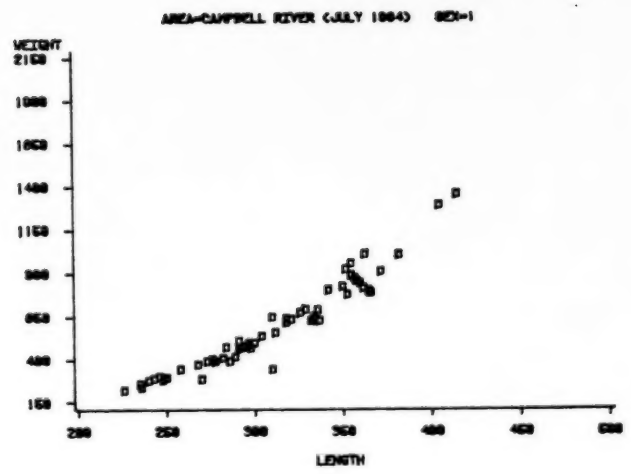

AREA-STUART IS (DECEMBER 1984) SEX=2
WEIGHT
2150
1900
1650
1400
1150
900
650
400
150
200
250
300
350
400
450
500
LENGTH

Fig. 12 (cont'd)



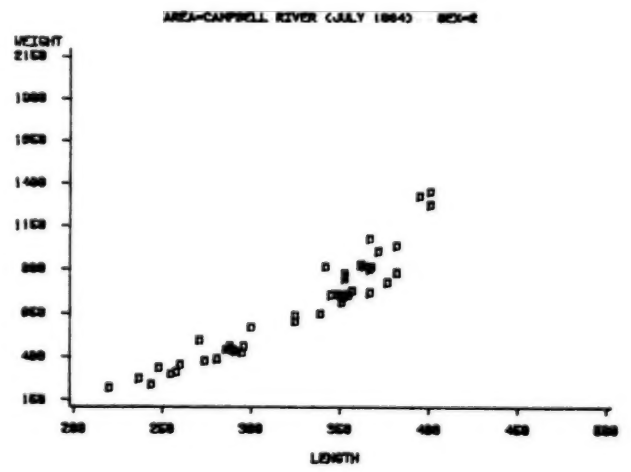
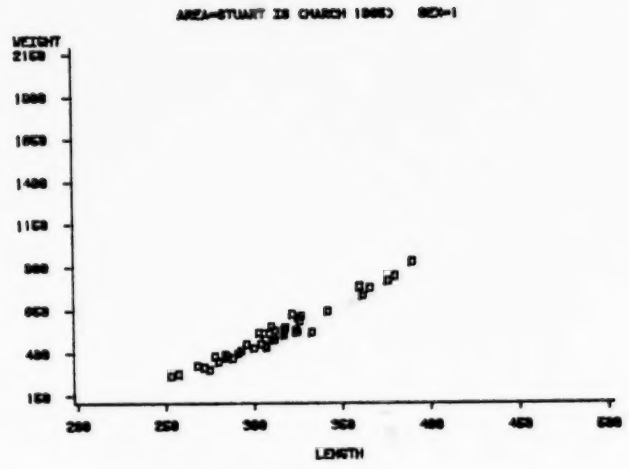




Fig. 13. Weight-length relationships for male and female copper rockfish in samples collected from the commercial rockfish handline fishery in Statistical Area 13 between July 1984 and March 1985 by area and date of collection. Male = 1 Female = 2.



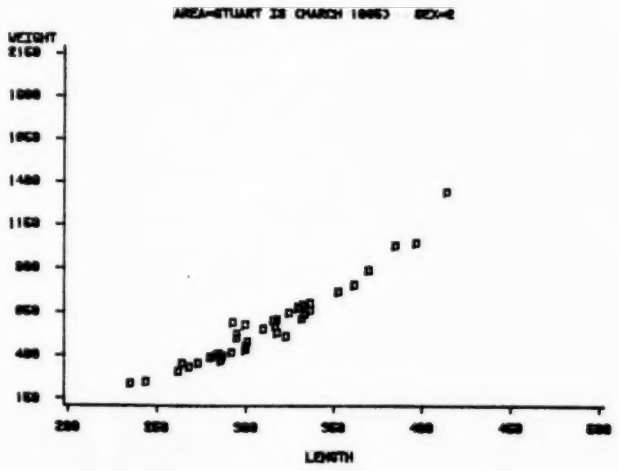




Fig. 13 (cont'd)

APPENDIX 1. Codes used to describe rockfish maturity stages, from Nagtegaal and Farlinger (1980), based on maturity stages described by Westrheim (1975).

| MATURITY | CODE | GONAD CONDITION |
|---|---|---|
| | 0 | UNKNOWN |
| | 1 | IMMATURE (TRANSLUCENT;MALES,STRINGLIKE;FEMALES SMALL) |
| FEMALES | 2 | MATURING (SMALL, YELLOW EGGS; TRANSLUCENT OR OPAQUE) |
| | 3 | MATURE (LARGE, ORANGE-YELLOW EGGS; OPAQUE) |
| | 4 | FERTILIZED (LARGE, ORANGE-YELLOW EGGS; TRANSLUCENT) |
| | 5 | EMBRYOS OR LARVAE (INCLUDE EYED EGGS) |
| | 6 | SPENT (LARGE, FLACCID, RED OVARIES. A FEW LARVAE MAY BE PRESENT) |
| | 7 | RESTING (MODERATE SIZE, FIRM, RED-GREY OVARIES) |
| | 8 | RESORBING |
| MALES | 2 | MATURING (STRINGLIKE, TRANSLUCENT, WHITE) |
| | 3 | DEVELOPING (SWELLING, BROWN-WHITE) |
| | 4 | DEVELOPED (LARGE, WHITE; EASILY BROKEN) |
| | 5 | RUNNING (RUNNING SPERM) |
| | 6 | SPENT (FLACCID, RED) |
| | 7 | RESTING (RIBBON-LIKE; SMALL, BROWN) |